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New Technology for Industrial Lead Acid Battery

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1 Abstract

Today, the demand for lead acid battery have constantly grown in use, such as vehicle, industrial backup, and industrial starter, and the improving performance of lead acid battery can afford no further delay. In addition, as the interest to the environmental aspect increases, resources saving batteries are required.

It is an ultimate challenge to improve the four elements of the lead acid battery, including battery capacity, high rate discharge performance, service life, and environmental applicability.

For this solution, this article will introduce our latest technology, Pure lead, Punching, Carbon technology (hereinafter referred to as PPC). This technology has combined the cutting edge of the carbon material compounding techniques with innovative structure design, greatly enhancing the battery performance. Moreover, we have developed an automation system for the PPC technology, achieving product quality stabilization and high yield rate. The technology will also reduce water and energy usage, resulting to reduce carbon footprint, and achieving to produce an environmental friendly product.

2 Characteristics of the Developed Technology

- Alloy material with no grain boundary corrosion applied to grid improves the corrosion resistance and battery life.
- Integration of terminal with copper core embedded and strap by automatic welding reduces welding defects. Shorter electrically conductive path and larger area of piercing welding section decreases heat generation and improves performance in high-rate discharge.
- The alteration of manufacturing methods of a grid results in a lightweight thin grid with a smaller mesh opening, which improves electrical conductivity and the active material utilization.
- Adding electrically conductive carbon to negative active material leads to larger the specific surface area, better conductivity and charge acceptability.

3 Background of the Development

With technology evolving rapidly and demand in energy market increasing continuously, related technology advances ceaselessly for wider application of industrial lead acid battery.

Table 1 shows the challenges we face currently and strategy. The PPC technology was developed by changing the design structure and introducing new materials aiming at longer life and superior performance during high-rate discharge. **Figure 1** shows the main factors technology.

Table 1 Issues and their measures of a lead acid battery

Challenges of lead acid batteries	Characteristics of related component materials	Strategies
Short battery life	Corrosion resistance of the grid	Improving corrosion resistance by alloy materials modification
Temperature increase by high-rate discharge	Conductivity of terminals and strap zone	Decreasing heat generation by changing the design of the conductive part structure
Satisfaction of high output	Energy stored in the electrode plate group (high rate discharge performance and charge acceptability)	Modifying the grid manufacturing method and increasing the electrode plates
Low utilization of active materials		Improving the surface area and porosity of the electrode plates
Energy consumption due to excessive charge time		Improving charge acceptability by adding a carbon material with electrical conductivity

4 Technical Details

The large crystals in existing Pb-Ca-Sn alloy prone to degrades from grain boundary corrosion. The Pb-Sn alloy adopted by PPC technology with smaller crystals is corroded by general corrosion (**Figure 1 (a)**).[1] The amount of corrosion of a grid made of Pb-Ca-Sn alloy is 132.1% of that of a pure lead grid, and the amount of Pb-Sn alloy is 71.9%. The adoption of Pb-Sn alloy reduces corrosion rate of the grid and extends the battery life.

To enable higher output during high rate discharge, the PPC battery structure was improved (**Figure 1 (b)**). By changing to integration of COS electrode with electrode and copper core pre-embedded and strap using the COS (cast-on strap) construction method shortened the conductive paths. Furthermore, enlarging the contact area of the piercing welding section between the cells reduced internal resistance. Introducing an automated facility improved the production speed and suppressed the generation of defective welding, lead flow, and fusing caused by manual welding, which resulted in great improvements in the yield rate. As a result of changing the structure, the amount of heat generation at discharge in the strap is reduced by 60% and that in the terminal section between the cells by 58%. Consequently, these reductions improve performance in high-rate discharge.

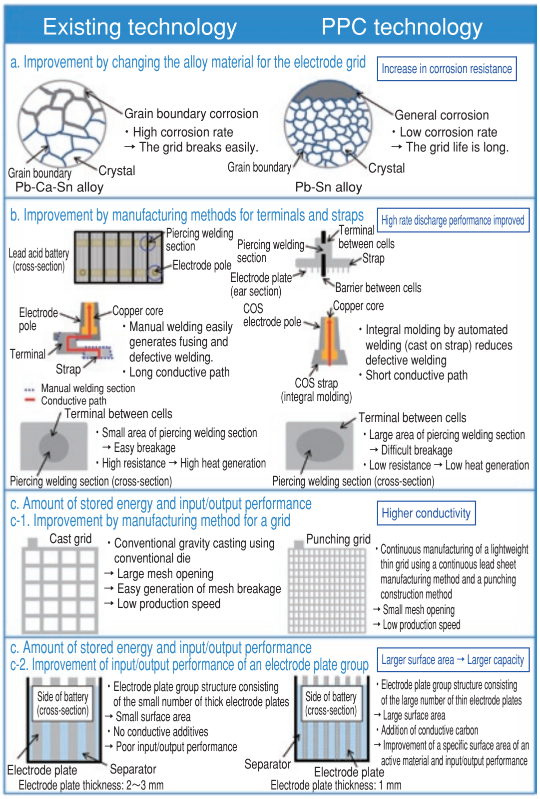

Figure 1 Developed new technologies for industrial lead acid battery

PPC technology enabled the creation of a thinner grid (**Figure 1 (c-1)**) with a smaller mesh opening using a continuous lead sheet manufacturing and punching methods in order to the reduction in weight and thickness. This improved conductivity and enabled an increase in the number of electrode plates to be installed even in the same battery size, which led to an increase in energy storage (**Figure 1 (c-2)**).

Furthermore, the addition of electrically conductive carbon to the negative active material improved the charge acceptability and suppressed[2] the sulfation of the negative electrode, which is the main degradation factor in lead acid batteries. In addition, the charge-discharge acceptability of the electrode plate is also improved.

Besides, the increase in battery capacity due to the increase in the amount of an active material per electrode plate contributed to the fact that the discharge capacity of the PPC battery improved by 25% in a 15-minute rate discharge and by 43% in a 5-minute rate discharge, in comparison with current batteries. In addition, the use of an alloy with a small change in the composition at re-melting achieves 100% of the reuse rate of punched lead. **Table 2** shows a comparison between the PPC battery and current batteries.

Furthermore, in PPC technology, the adoption of a battery jar forming system, in which electrification is performed after the battery is assembled, allowed the forming and charge processes to be integrated, in comparison with the tank forming used in the conventional charge system. This system not only eliminated the water washing and drying process but saved energy and reduced CO_2, as well as providing an environment friendly manufacturing process.

Table 2 Performance comparison between the current battery and PPC battery

Indices for reference	Current battery	PPC battery	Expected effects
Amount of corrosion of a positive grid (%)	100	54	The usable life (years) increases, and battery exchange expenses are reduced.
Amount of heat generation due to discharge (%)	100	40	High-rate discharge is possible, and energy savings are achieved for air conditioning at the place of installation.
Increase rate of 15-minute rate discharge capacity (%)	100	125	The following are all reduced: the number of batteries, the number of battery racks, the space occupied, and battery inspection expenses.
Increase rate of 5-minute rate discharge capacity (%)	100	143	

5 Future Business Development

・Increase the battery models adopting this technology.

[References]

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2) K. Nakamura, M. Shiomi, K. Takahashi, and M. Tsubota, J. Power Sources 59(1996)pp.153-157.